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THE INTERNAL SECRETIONS AND HUMAN WELL-BEING[1]

By Professor M. F. GUYER

UNIVERSITY OF WISCONSIN

PERHAPS there is no field of biological investigation to-day that is attracting more attention on the part of both biologists and the public than that concerned with the glands of internal secretion—secretions which do not pass out from their place of origin through ducts as do ordinary glandular products, but which are absorbed directly into the blood or lymph and circulated through the body. The interest of the public has been aroused in this new knowledge through its rather wild exploitation in the press under such captions as "The Chemistry of the Soul," "The Glands of Destiny," "Rejuvenation through Monkey Glands" and other equally sensational titles, together with the occasional truths that filter through from time to time regarding the really remarkable part played by the internal secretions—or hormones as they are technically called—in our physical and mental well-being.

The ductless or endocrine glands which produce these various internal secretions occur in all backboned animals from fishes to man. The secretions themselves are second in importance only to the nervous system in keeping the parts of the body in harmonious operation. They are also necessary for normal development and growth. They can stimulate or inhibit the activity of some organ or tissue in a part

[1] Address given at the forty-fifth annual meeting of the Iowa Academy of Science, May 1, 1931; in substance, a section from the author's forthcoming textbook, "Animal Biology," published by Harper and Brothers.

of the body far distant from the source of the secretion itself. While the modest achievements of the biologist, the pathologist and the biochemist toward an understanding of the nature and functions of the internal secretions do not measure up to the expectation of a public appetite fed mainly on sensationalism, still the facts, unmagnified by the imagination, are certainly both interesting and significant.

Many physical and even mental abnormalities in man are being traced to deficiencies of the endocrine glands, or to upsets of their normal interrelations at different physiological periods in the individual. Height, the general form and external appearance of the body, whether slender or broad, the length of arms and legs, the shape of the face, the quality of the voice, the distribution of hair or of fat on the body, and even the emotions are in greater or less measure conditioned by the relative functionings of these regulative substances during early development and later life. Furthermore, the amount and quality of the internal secretions in various family strains are probably as much the expression of hereditary factors as are many other individual characteristics; hence the problem as it affects existing personality and health is not only one of present physiology but also one of parentage.

The known endocrine glands are the thyroid, the parathyroids, the pituitary body, the adrenals, the sex-glands and special areas in the pancreas, the stomach and the upper intestine. The pancreas, male sex-glands and the glands of the stomach and intestine also form other secretions for the discharge of which ducts are provided. The hormones formed in these glands, however, as in the ductless glands, are absorbed directly into the blood and lymph. The thymus, pineal body, spleen, liver, lymph glands, kidneys and heart have also been suspected of endocrine functions, although the evidence as yet is inconclusive.

The thyroid arises embryologically as an outgrowth from the digestive tract in the neck region; it soon becomes shut off from its place of origin, however, to form a ductless gland. Its final position and appearance vary considerably in different kinds of vertebrates. In man it consists of two lobes attached to the sides of the lower portion of the larynx, connected by a narrow band across the midline. The thyroid of an average sized, normal man weighs from 20 to 25 grams. It is slightly larger per unit of body weight in woman, and still larger in proportion to body size in children. Its secretion plays a very important part in maintaining a proper balance of the nutritional and growth processes. The active principle, known as thyroxin, was first isolated by the biochemist Kendall in the form of an organic iodin compound containing no less than 60 per cent. of iodin. It is now prepared synthetically by chemists; the artificial product is apparently as effective as the natural.

Thyroxin regulates the rate of oxidation in the body. Over-abundance (hyperthyroidism) increases the heart-beat, causes higher temperature, and in general speeds up the body activities. Thyroid insufficiency (hypothyroidism) on the other hand, causes the chemical processes of the body to proceed sluggishly: glandular, muscular and mental activities are impaired; the temperature is lowered, and in adults the skin, especially of the face and hands, may become puffy from the presence of underlying mucus (myxedema). Inadequate development or atrophy of the thyroid in the young child produces a condition known as cretinism characterized by stunted body and imbecile mind. The tongue and abdomen of the cretin tend to protrude and the legs are usually bowed. Such children, if taken in time, often show remarkable improvement, both in body and mind, following administration of thyroxin.

Simple (or endemic) goiter is a pathological enlargement of the thyroid gland. That iodin deficiency is an important and possibly the sole cause is indicated by the fact that many remarkable cures have been effected in early stages through the administration of iodin in some form and by the fact that this form of goiter may be largely prevented through the use of food which contains traces of iodin or by the occasional addition of small quantities of iodin salts, commonly sodium iodide, to ordinary food. That this is an important matter is evident from the fact that in the so-called "goiter belts" some 20 to 30 per cent. of the male and some 50 to 60 per cent. of the female inhabitants show at least traces of thyroid enlargement. Goiter is two to three times more prevalent in females than males. It is very common in the Great Lakes region of our own country and is usually found in glaciated regions where the iodin content of soil and water is low as compared with that of coastal plains. Goiter may occur in any land or fresh-water vertebrate. Animals living in the sea are free from it probably because sea water is rich in iodin. The enlargement is brought about apparently by overwork on the part of the gland in an attempt to secrete enough thyroxin for the use of the body in spite of an insufficient intake of iodin. Such an effect is termed compensatory hypertrophy. It is probable also that at times increased need in the body for the iodin-containing hormone may be a factor in goiter production. It is most likely to occur at the times of life when energy transformations are greatest such as, in man, during fetal life, puberty, in periods of

pregnancy and lactation and toward the conclusion of the child-bearing period in women.

As affecting development some interesting experiments have been performed with thyroid upon tadpoles. Guternatsch discovered that both frog and salamander tadpoles fed on thyroid are forced into premature maturity. Frog tadpoles quickly develop legs, absorb their tails and transform into miniature frogs, sometimes no larger than a fly. Allen has shown, on the other hand, that a young tadpole deprived of its thyroid is unable to become a frog though it continues to live and may grow far beyond the normal size of a tadpole. If at any time such a tadpole is fed thyroid, however, it promptly undergoes metamorphosis. Thyroxin seems to be the same substance wherever found in the vertebrates from lamprey to man.

Although so necessary to the proper operation of physiological processes, only a very small trace—not over 12 milligrams or one fifth of a grain—of thyroxin is present in the normal body at one time. One milligram of thyroxin fed to a man at rest weighing 150 pounds will increase his rate of oxidation 2 per cent. for twenty-four hours. The total amount of this substance needed for an entire year to keep the human body in normal health is only about three and one half grains, yet lacking this, the individual becomes an imbecile. The so-called basal metabolism test is employed to discover if too much or too little thyroxin is present in an individual. A normal resting person who has not eaten for twelve hours produces a remarkably constant amount of energy in a given time as shown by the even carbon dioxide output which results from internal oxidation. In people suffering from goiter or from lack of thyroid activity, the severity of the hyper- or the hypo-thyroidism is judged by the deviation of the rate of internal oxidation from that of a normal person.

The parathyroids (Gr. *para,* near; and *thyroid*) in man exist as four minute glands weighing in all not over two grains. They are closely attached to the thyroid, one on the side and one on the median surface of each lateral lobe. They have been identified in all kinds of vertebrates except fishes. The secretion from the parathyroids controls the calcium content of the blood, and since calcium is of great importance in many physiological processes from clotting of blood and muscular tone to formation of the skeleton, the proper functioning of these glands is all-important to the organism. Complete removal brings about a condition known as tetany, characterized by painful spasmodic contractions of the muscles of the extremities. The calcium content of the blood is greatly diminished. The heart, the respiratory tract and the temperature of the body are also affected. Death results in a few days after the removal of the glands if the condition remains untreated. Injection of a soluble calcium salt will relieve the attack of tetany and restore the sufferer to normal for a time.

The thymus is a glandular structure which in man is located in the upper chest region along the trachea. In lower forms such as fishes it may take the form of a number of separate bodies. Although commonly regarded as a ductless gland its function is a matter of debate. The secretion has never been successfully isolated. By some it is thought to be a structure which functions in the formation of blood. Since, in man, it attains its maximal size and activity in early childhood, the inference is that it fulfills some important function in the young developing organism. After the second year of life, ordinarily it gradually grows less in size until usually at about the end of the thirteenth year it is supposed to disappear. However, cases of "persistent thymus" are not uncommon. At first supposed to be confined to individuals characterized by prolonged childhood, and to be particularly characteristic of feebleminded adults, renewed study of cadavers shows that persistence in apparently normal individuals is by no means uncommon. Young dogs in which the thymus has been completely removed develop a softening of the bones, and surgical removal in a human being is said to produce a disordered development of the skeleton similar to that of a child with rickets.

The pineal gland is a small body in the brain of vertebrates, projecting from roof of the third ventricle, from which it is an outgrowth. In man it is about the size of a pea. The philosopher Descartes regarded it as the seat of the soul! There seems to be some evidence that it secretes a hormone, although it has never been isolated. The gland seems to be most active during childhood and by some endocrinologists is believed to take over the supposedly inhibitive functions of the thymus after the second year of life. Early destruction or degeneration of the gland, as by a tumor, has been found associated with precocious sexual maturity in a few children. Delayed retirement of pineal activity is alleged by some endocrinologists to lead to obesity and retardation of sexual development.

The pituitary gland is a small body of double origin, attached by a stalk to the base of the brain. It occurs in all vertebrates from hag-fish to man. The anterior portion arises embryologically from the roof of the mouth, and the posterior portion is an evagination from the floor of the brain immediately above the mouth. The respective outgrowths fuse to form what is commonly called the pituitary body or gland. The posterior part forms the posterior lobe

or *pars nervosa* of the pituitary gland. The anterior outgrowth ultimately gives rise to three distinct parts—an anterior lobe, an intermediate lobe and a thin layer called the *pars tuberalis,* which comes to surround the stalk and extend upward onto the base of the brain. The different parts have different functions.

In normal man the pituitary body is a small structure about the size of a hazel-nut, weighing approximately 0.6 gram. It lies in a bony depression (*sella turcica*) of the sphenoid bone in the floor of the skull. The earlier work done with extracts from the posterior lobe produced seemingly very divergent results due probably to the fact that such substance is easily injured by the reagents used in its preparation, to differences in size of dose, and probably also to the fact that, as recent investigation has shown, more than one hormone is involved.

The most consistent results obtained from use of the entire extract of the posterior lobe are: (1) extraordinary potency as a stimulant of smooth muscle (hence its use in hastening child-birth by causing powerful uterine contractions); (2) prolonged rise in arterial blood pressure; (3) a diuretic (increasing the secretion of urine) action, or, under some conditions, an antidiuretic reaction; and (4) characteristic cardiac, glandular and respiratory effects. Kamm and his coworkers, however, have succeeded in separating from powdered posterior lobe substance two products, one of which acts powerfully on blood-pressure but has very slight action on uterine muscle while the other does not affect blood-pressure but is a powerful stimulant of uterine contraction. In addition to these substances two materials which lower blood-pressure are known to exist in posterior lobe extracts.

The secretion of the anterior lobe is best known through its growth-stimulating and ovulation-inhibiting effects. Over-activity of this lobe probably leads to gigantism, insufficiency, to dwarfing. Removal of the anterior lobe in young experimental animals results in a marked stunting in size. Injections with anterior lobe extracts, however, cause growth to be resumed. By daily injections of anterior lobe-substance into the body-cavity, giant rats have been produced. In one case a treated animal became more than double the size of untreated litter mates. Gigantism has likewise been similarly induced in various amphibia. Autopsies on various human giants have revealed tumorous and enlarged pituitaries. If the excessive secretion begins in youth while the growth zones of the bones are still unossified, lengthening of the bones, particularly of the arms and legs, occurs, and a form of gigantism is the outcome; but if such overactivity does not appear until maturity a different type of enlargement occurs in certain bones, notably those of the hands, feet and face, and a condition of deformity known as acromegaly results.

As regards sterilization by means of anterior lobe extract, the contradictory reports which have filled the literature for the past few years seem at present in a fair way of being cleared up. Most studies have reported inhibition of ovulation in mice and rats following hypodermic injections of the extract. A few, particularly where minimal amounts were used, have recorded increased ovulation and the precocious maturity of young animals. Miss Claus, however, succeeded in isolating a crystalline product from the anterior lobe which very materially hastens sexual maturity in young mice. The residue left after the removal of such crystals was shown still to contain the growth-promoting and the ovulation-inhibiting substances. Thus there are evidently at least two different hormones in the anterior lobe secretion, and it seems not improbable indeed that this non-crystalline residue may be further fractionated into two, making three in all.

Working with frog tadpoles, B. M. Allen has shown that limb development ceases at a certain point following removal of either the thyroid or the pituitary gland or both. He interprets his results as indicating a close correlation of function between the two. He has demonstrated also that tadpoles from which the pituitary body has been removed lag greatly in growth but that following implants of the anterior lobe alone, growth rises rapidly to normal again. Implantation of either the intermediate or the posterior lobe has no such restorative effect. Striking increase in pigmentation in such tadpoles, however, is produced by implantation of the intermediate lobe.

One of the most spectacular effects of transplanting the anterior lobe is perhaps that obtained by Miss Wolf on the breeding habits of the ordinary leopard frog (*Rana pipiens*). This animal breeds once a year, in April, laying its eggs in lakes, streams and fresh-water pools. However, females treated in the fall or early winter with daily implants of a single fresh anterior lobe taken from another frog may be stimulated in from four days to a week to lay eggs in a perfectly normal manner. Males similarly treated, after the second or third treatment, usually begin to sing as they do during the mating season in spring, and in the course of a few days all the normal mating instincts appear, the eggs are fertilized and normal development occurs. Tadpoles are now secured in this way in our own laboratories at any time we may need them for class or individual work.

Taking pituitary secretion as a whole the available

evidence shows that an excess increases the basal metabolic rate and that a deficiency leads to excessive obesity and retardation of sexual development. Indications of close interrelation between the pituitary and various of the other endocrine glands such as thyroids and ovaries are steadily accumulating.

The pancreas is seemingly a gland concerned primarily with the elaboration of a digestive fluid which is discharged through the pancreatic duct into the upper intestine. Scattered throughout the pancreas, however, among the lobules which secrete the ordinary pancreatic juice, are small independent areas of a very different-looking tissue known as the islets of Langerhans. These cells secrete a substance known as insulin which passes directly into the blood-stream and serves, probably in cooperation with the secretion of the adrenal glands, to control the metabolism of sugar in the body. If these islets are incapacitated in some way an insufficiency of insulin occurs and a condition known as diabetes (*diabetes mellitus*) results. A characteristic symptom of diabetes is increase of sugar in the blood and later the appearance of sugar in the urine. Insulin was discovered, and a method of preparing it from the pancreas of healthy animals was perfected by Banting, Macleod and associates. This preparation is now widely used in the treatment of diabetes and is restoring the general health and prolonging the lives of many diabetics. It is interesting to note in connection with the pancreas also that secretion of the pancreatic digestive fluid does not proceed until the pancreas is stimulated by a hormone known as secretin. Secretin in turn is produced in the walls of the small intestine as a result of the entrance of the acid contents of the stomach following gastric digestion.

The adrenal glands as the name implies (L. *ad*, near; *ren*, kidney) are associated with the kidneys, although in the lower mammals they are not as closely connected with it as in man. Each gland is a double structure of dual embryonal origin. The core or medullary portion springs from certain cells of the adjacent sympathetic nervous system, while the cortical portion which comes to envelop the medulla is derived from the lining of the body cavity. The secretions from the two parts differ in physiological action. Inasmuch as cells giving reactions similar to those of the adrenal medullary cells have been described in annelids and mollusks adrenal secretion or its equivalent seems to be of wide occurrence in the animal kingdom. The adrenal glands of man are two small structures of a yellow color, which cap the kidney and weigh about 4 grams each. They are about the size of a man's thumb.

The secretion from the medullary portion of the adrenal gland, called adrenalin or epinephrin, has not only been isolated in a pure state but has also been synthesized in the laboratory and is widely used as a drug. In the body it is of great importance in maintaining muscular tone; the proper amount keeps the blood vessels suitably contracted and blood pressure normal. It is normally present in blood in about the ratio of only 1 part to 20,000,000.

Insufficiency of adrenalin in the blood results in lowered blood-pressure, lack of muscular tone and the general loss of strength and "nerve" which is characteristic of neurasthenia, "shell-shock" and related ills. In general, adrenalin affects the same structures of the body that the sympathetic nervous system does; namely, the heart, blood-vessels, kidneys and other viscera, and the involuntary muscles. It is widely used in minor surgery because it constricts blood-vessels and thus checks bleeding. Tadpoles fed on adrenal gland become extremely light colored or "bleached," apparently because it produces contraction of the pigment cells. Injection of adrenalin into the blood leads to increase in the quantity of sugar in the blood through release of the sugar from liver glycogen. It apparently counter-balances the action of insulin. It is used medicinally to relieve bronchial spasms in asthma, and in conjunction with local anesthetics for constricting blood-vessels and thus preventing rapid diffusion of the injected substance. It is also sometimes used in attacks of hives or hay fever. Injected directly into the heart in certain cases of collapse, it will sometimes, through its effect on certain nerves, initiate renewed contraction in a heart that has ceased to beat.

Professor Cannon and his associates conclude from their experiments that under stress of such emotional states as pain, suffocation, fear or rage, the adrenals are stimulated to an increased output of adrenalin. Cannon calls attention to what he regards as the remarkable adaptive character of the reactions which follow, in that they supply the body with muscular power to resist or carry out any of the actions that may take place under these emotions for the welfare or preservation of the individual. According to him the sugar of the blood—the most favorable source of muscular energy—increases in quantity; if digestion is in progress its activities are suspended and the blood is shifted to the organs immediately necessary for muscular exertion—the lungs, heart and central nervous system; the blood becomes more coagulable; heart action becomes more vigorous; muscular fatigue is counteracted by the extra adrenalin; in brief, such fundamental readjustments are instituted as are favorable to great feats of strength or endurance—for fight or flight. According to Cannon's view, then, adrenalin is a chemical agent which cooperates with

nervous factors in helping the body meet the emergencies of existence.

Removal of the adrenal cortex results in death in the case of man or such animals as the dog or cat. But injections of cortical extracts will keep such animals alive. A serious malady in man known as Addison's disease, characterized externally by bronzing or pigmentation of the skin, is associated with pathological changes in the adrenal cortex. Such patients, however, show improvement following injections of cortical extracts.

So far no specific secretion has ever been definitely isolated from the cortex, and its functions are therefore not so well understood as those of the medulla. Inasmuch as cortical enlargement (hypertrophy) has been found to be associated with precocious sexual development it is inferred that one of its functions is concerned with determining and controlling sexual maturity. Overactivity of the adrenal cortex apparently causes marked accentuation of the masculine traits. Women so affected acquire masculine characters, such as beard, deep voice and coarse features. Cortical tumors have apparently caused even young children to develop the sexual characteristics of the adult. Some bits of evidence indicate that the cortical secretion serves also to neutralize certain poisonous products of protein metabolism.

It has long been known that the generative glands (gonads) besides forming germ-cells also produce internal secretions which influence the individual profoundly, both mentally and physically. These secretions are indispensable for the proper development of the specific male and female characteristics. Much experimentation has been in progress with the lower animals in this connection in recent years and many interesting facts determined. In certain mammals such as the rat or guinea-pig, for instance, if the ovaries of a female are transplanted into a male which has been previously unsexed, the latter under stimulus of the ovarian secretions assumes a behavior like that of the female. Its hair and skeleton come to resemble more those of the female than of the male, and its rudimentary milk glands become enlarged to functional size.

If the ovary of a mallard duck is completely removed, at the succeeding moult she takes on the very different plumage of the male. Likewise, if the ovaries are removed from very young hens they develop to a greater or lesser degree the more ornate plumage, the spurs, wattles, comb and larger size of the cock. The development of these characteristics will be still further increased if extract of the male gonad is injected, or if the gland itself is transplanted to such castrates.

A remarkable experiment which reveals the importance of the sex hormone in sex differentiation has been discovered by Professor F. R. Lillie in his study of the "free-martin," a sterile female calf born as a twin to a male calf. In cattle when twins, one male, the other female, arise, the blood-vessels in the fetal membranes of the two embryos may fuse in such a way that their blood intermingles. The male gonads develop ahead of those of the female with the result, according to Professor Lillie, that the male sex hormone is the first to pass into the joined circulatory systems. It interferes with the growth of the ovary in the female, causing sterility and modifying more or less profoundly various of her secondary sexual characters so that they tend to assume the male condition. Witschi has shown that such a male influence is also exerted when tadpoles are grafted together in pairs, the females attached to a male being made masculine. Burns has shown that if salamander tadpoles are grafted together in pairs, when the individuals happen to be of different sex the sex hormones of the one—sometimes the female, sometimes the male—are likely to alter profoundly the sexual system of the other.

In the female of the vertebrates, at least, the rhythmical occurrence of ovulation is correlated with rhythmical changes in the secretions of the ovary. In mammals the hormones so far identified with the ovary have been derived from two sources; namely, the follicular fluid which surrounds the egg before it is shed from the ovary and the corpus luteum, a yellowish mass of cells which come to fill the ruptured follicle after the egg has been discharged. The follicular extracts differ decidedly in function from those of the corpus luteum, although there appears to be a reciprocal or supplementary relationship between them. The corpus luteum increases in size for a time and then undergoes retrogressive changes and is finally absorbed. The duration of this growth period depends upon whether or not the discharged ovum has been fertilized and is developing in the uterus. If such development is in progress the corpus luteum increases in size, becoming what is known as the corpus luteum of pregnancy; it persists for a considerable time, depending upon the length of gestation. If development of the embryo is not taking place in the uterus, the corpus luteum disappears shortly and a new follicle gradually accumulates liquid, projects from the ovarian surface and at the proper interval discharges another ovum. Thus the cycle of ovulation (oestrous cycle) is repeated rhythmically unless interrupted by pregnancy. There are indications, however, that the hormone from the anterior lobe of the pituitary body has some part in stimulating the ovary to renewed ovulation. Not only periodic changes in the ovary itself but in the

uterus, mammary glands and other parts of the body are brought about through the agency of the ovarian hormones. Allen and Doisey have succeeded in preparing a hormone from follicular liquid which restores the normal mating instincts and the characteristic sex cycle in rats and mice in which these had been lost as a result of removal of the ovaries. This extract, when used on young animals immediately after weaning, induces precocious sexual maturity. Not only will follicular hormone when repeatedly injected cause development of the mammary glands in females from which the ovaries have been removed but it will likewise stimulate the mammary glands of males to develop. A similar hormone has been obtained from placental tissue and the amniotic fluid which surrounds the developing fetus; also from the urine of pregnant cows and pregnant women.

The corpus luteum hormone seems to have as one of its functions the preparation of the uterine wall for implantation of the fertilized ovum, for if the corpora lutea are destroyed implantation does not occur. Hisaw has shown, however, that what he calls a "one, two" reaction is involved—that the uterine mucosa must first be sensitized by the follicular hormone before the corpus luteum extract is effective. On the other hand, injection of follicular hormone following implantation will cause abortion. Hisaw has also isolated from ovarian extracts a crystalline product which he terms a "relaxative hormone" because it relaxes the pubic symphysis before parturition and thus facilitates bearing the young. That it is not the only hormone of the corpus luteum is shown by the fact that the non-crystalline residue left after removal of the relaxative hormone still retains the other endocrinal functions of corpus luteum extract. Hisaw has recovered this relaxative hormone also from the placenta and from the blood and the urine of various pregnant mammals, including human beings. The corpora lutea of pregnancy also apparently supply a hormone which inhibits ovulation during pregnancy and which stimulates the development of the mammary glands.

As regards the internal secretions of the testes Moore has succeeded in isolating testicular extracts which when repeatedly injected into castrated males restores all the characteristic masculine behavior and structures except the gonads themselves. It is commonly believed that the internal secretion of the testes is furnished by so-called interstitial cells which lie outside the tubules which produce the germ-cells, inasmuch as the latter can be caused to atrophy while the interstitial cells remain unaffected and the animal yet develop or maintain its normal sexual characteristics.

The great importance of endocrine glands in controlling the later development of vertebrates, particularly the rôle they may play in determining the conformations of various parts of the body, opens up the important issue of how much such similarities are to be attributed to direct heredity, how much to endocrinal activities. Certain types of defectives, such as cretins and so-called Mongoloids, even when of different races, often show marked resemblances. The abnormalities in the case of cretins are ascribed to endocrine—particularly to thyroid-deficiency in the affected individual—and those of the Mongoloids are supposedly the result of endocrine disturbances in the mother or to fetal nutritive insufficiency. The Mongolian facial type, however, is also prevalent in cretins and may result from insufficiency of thyroid secretion during the growth period, since such lack is known to have a characteristic effect on the bones of the nose and the base of the skull. Thyroid as well as pituitary insufficiency may also be an important factor in dwarfing. From the standpoint of heredity, therefore, a peculiarity in a particular structure might have its immediate determining cause in the output of an endocrine gland, but if inheritance is involved, the determining genes would be those responsible for the changed condition of the gland in question, not for the visible, finished trait.

That all such developmental anomalies can not be attributed wholly to improper functioning of some endocrine gland of the affected individual, however, is shown by the fact that certain of them reveal their presence far back in the early fetus before its endocrine glands are functional. This is true, for example, of the achondroplastic dwarf, characterized by abnormally short and somewhat twisted arms and legs, with head and trunk of approximately normal size. Such individuals have many of the evidences—disproportionately broad face, low nose-bridge, overhanging forehead, undershot jaw—of thyroid deficiency. This abnormality, furthermore, can not be attributed, in all cases at least, to endocrinal defects of the mother, since pedigree tabulations are known which clearly show that the condition can be transmitted from the paternal side. Such a characteristic shaping-up of the head and face is due to lack of growth of the skull base. Professor Stockard points out the resemblance of this condition in man to that found in certain breeds of the lower animals such as the bulldog and the pug-dog, and maintains that the underlying cause is probably the same in each. He believes, from our knowledge of their inheritance and development, that the primary cause lies in a germinal mutation or sport and that the endocrinal effects are secondary.

The English anatomist Keith is inclined to regard

the primary differences which mark off the races of man as due to the relative activities of various endocrine glands. While his opinions are highly conjectural they are suggestive and show the importance of further investigation in this interesting field. Stature, for example, is largely regulated by the secretion from the pituitary gland, and Keith maintains that the average European is taller than the average Negro or Mongolian because of the more pronounced activity of this gland in the Caucasian type. The pituitary also probably influences the character of the hair, the texture of the skin, and the cast of features. Hormones from the male gonad are apparently responsible for the main secondary sexual differences. Judging from the more heavily haired condition of the body in Caucasians, he likewise infers that this tissue is more active in them than in the Mongolian and Negroid types. Again, he thinks that the lighter color of the paler-skinned races may have been produced by a greater activity of the adrenal glands, since their secretion tends to destroy pigmentary bodies. According to his hypothesis, then, the Caucasian type is characterized by a relatively greater amount of internal secretion from gonads, and from pituitary, thyroid and adrenal glands. Since racial characteristics are inherited, however, it is evident that such differences of mind or body, in so far as they are referable to the influence of internal secretions, must be assigned eventually to the germinal factors which determine the corresponding differences in the endocrinal glands.

In conclusion, then, I think it is evident from even this cursory review of the endocrine system that we have in the internal secretions a series of powerful agents which profoundly influence our body-structure, our health and our whole personality.

SCIENTIFIC EVENTS

DROUGHT IN THE NESTING AREAS OF WATERFOWL OF THE UNITED STATES AND CANADA

THE reports of representatives of the U. S. Biological Survey who have recently returned from expeditions to northern areas of the United States in company with Canadian officials to the principal duck-breeding areas in Canada indicate that severe limitation of the number of waterfowl to be killed during the coming season may be necessary as a result of long-continued drought in the nesting areas. Although federal regulations governing the shooting of ducks and geese were recently amended to reduce the open season throughout the United States by two weeks this fall and winter, still further restriction of the annual kill may be necessary.

Discouraging reports were made of unprecedented drought; of lakes and ponds and marshes turned into dusty barrens with no sign of aquatic life, and of the almost complete absence of water during the period in the great prairie breeding grounds of southwestern Manitoba, southern Saskatchewan as far north as Saskatoon, and Alberta westward to the foothills of the Rocky Mountains and northward to the vicinity of Edmonton.

A marked shortage of breeding ducks and young was noted in the great delta region of the Peace and Athabaska rivers. In tours of several thousand miles the investigators saw only a few dozen small broods of young ducks in an area that in normal years has produced many millions of mallards, pintails, redheads, canvasbacks, bluebills and teals.

The shallow prairie sloughs and lakes of the region have disappeared following about ten years of reduced rainfall and three seasons of persistent drought. A far-reaching inquiry sent out by the Canadian Government has failed so far to show that the ducks have found other more remote breeding areas.

Not all the ducks and geese that come into the United States are bred in the region surveyed but a very large proportion of the wild fowl that make up the great flights know that country as their birthplace, and the shortage of breeding birds and the loss of so many young will have a serious effect upon shooting conditions both in this country and in Canada. Both the Canadian and United States governments under the migratory-bird treaty are concerned over the disastrous conditions that now threaten the wild fowl of the continent.

The two governments are therefore endeavoring to avert shortages by devising methods for saving an adequate supply of breeders for next season. The severity of the limitations that may be necessary will not be determined definitely until after further conferences between the authorities of Canada and of the United States and until more information is received from the nesting grounds.

To avert the grave possibilities of a permanent disaster to the wild fowl, the gunners in all sections of both countries will probably be asked to reduce their duck shooting this winter to a minimum, so that enough mature birds will survive to breed and thus enable the flocks to replenish themselves with the return of water to the parched areas.

THE INTERNATIONAL PASSAMAQUODDY FISHERIES COMMISSION

THE first members of the scientific staff appointed to investigate the Passamaquoddy fisheries for the

Canadian and American governments have arrived at St. Andrews and are preparing to institute work immediately. The object of the investigation will be to study the probable effect of the international development to generate electric power from the movement of tides in Passamaquoddy Bay and in Cobscook Bay on the fisheries of that region.

A joint meeting of the International Passamaquoddy Fisheries Commission and the advisory committee took place at the Atlantic Biological Station on July 10 at which the program was considered.

President Hoover has appointed Mr. Henry O'Malley, commissioner of fisheries, and Mr. O. E. Sette, in charge of the North Atlantic fishery investigations, as United States commissioners to conduct the investigation. The Honorable W. A. Found, deputy minister of fisheries, and Professor A. G. Huntsman, of the Biological Board of Canada, have been appointed to represent Canada in this investigation.

At a meeting of the commission in Montreal on June 8, to consider arrangements for starting the investigation, Mr. Found was chosen chairman of the commission, and it was decided that four experienced investigators should be selected to conduct investigations on zooplankton, phytoplankton, oceanic chemistry, and physical oceanography and fisheries. Dr. Charles J. Fish, director of the Museum of Science, Buffalo, New York, was selected biologist in charge of zooplankton and executive secretary to the investigative staff. Through the courtesy of the Buffalo Museum, Dr. Fish has been granted leave of absence for this work, and he is now engaged in organizing the investigation and securing subordinate personnel. Dr. E. E. Watson, of Queens University, Kingston, Ontario, a hydrographer with previous experience in local waters, has been appointed to take charge of the investigation in physical oceanography. Headquarters have been established at the Atlantic Biological Station at St. Andrews, New Brunswick.

The commission, and its investigative staff, has the assistance of an advisory committee, which consists of two competent scientific representatives from each country. Professor F. R. Hayes, of the zoological department of Dalhousie University, and Dr. A. W. H. Needler, in charge of the oyster investigations for the biological board, represent Canada. Dr. H. B. Bigelow, director of the Woods Hole Oceanographic Institution, and Professor A. E. Parr, curator of the Bingham Oceanographic Collection, Yale University, represent the United States.

Conclusions have previously been reached that the soundest basis for forecasting the probable effects of the dam upon the fisheries of this region would likely be investigations along the following lines:

(1) Detailed study of the occurrence of the herring in relation to various environmental conditions as an indication of how its availability in the fishery might be affected by the construction of the dams.

(2) The study of the abundance of phytoplankton and zooplankton (as a basis of fish life) in relation to the physical and chemical states of the water in the Bay of Fundy and along the coast of Maine.

(3) Detailed examination of existing hydrographic conditions as indicating the relative importance of the water-mixing at the mouth of the Passamaquoddy Bay as determining the physical and chemical states of the water in the Bay of Fundy and along the coast of Maine.

Two vessels have been loaned for use by the commission. The *Prince,* which in the past has been utilized by the Biological Board of Canada at St. Andrews, has been assigned to the new investigation and at the present time is being outfitted. The second vessel, the *Pelican,* recently constructed for the U. S. Bureau of Fisheries, will shortly leave Boothbay Harbor, Maine, and is expected to arrive in about a week's time. Active field work will for the time being be carried on by Dr. Fish and Dr. Watson. It is expected that additional members of the scientific staff will be announced later.

THE FARADAY CELEBRATION

THE celebration of the hundredth anniversary of the discovery of electro-magnetic induction by Michael Faraday will take place from September 21 to 23 at the Royal Institution of Great Britain where the experiment was made that has transformed our civilization.

Arrangements are being made for the welcome and entertainment of the delegates and guests beginning on Saturday, September 19. Officers of the Royal Institution, with interpreters and guides, will be in attendance to welcome arriving delegates and guests, and to afford any help that may be required. Ladies accompanying delegates and guests will be welcomed and entertained by members of a Ladies' Committee which has been formed for the purpose. Visits to places of interest have been arranged on each day of the celebration. By the courtesy of the general officers of the British Association for the Advancement of Science, delegates and foreign guests at the Faraday celebrations who are not already members of the association will receive complimentary tickets for its centenary meeting.

On Monday, September 21, there will be an informal meeting in the lecture theater of the Royal Institution where a statement regarding the program in English, French and German will be made. In the afternoon a reception for the delegates will be held in the lecture theater by the president and managers of the institution. A Faraday commemorative meet-

ing will take place at the Queen's Hall, Langham Place, in the evening, when short speeches will be made by distinguished representatives of institutions in various parts of the world. Music will be rendered by the Symphony Orchestra of the British Broadcasting Corporation, under the direction of Sir Henry Wood, and the proceedings will be broadcast. On Tuesday morning, September 22, there will be a conference at Kingsway Hall, at the Institution of Electrical Engineers. A conversazione will be held at the Royal Institution and at the Institution of Electrical Engineers at the Royal Albert Hall in the evening.

A private view of the Faraday Exhibition at the Royal Albert Hall will be extended to delegates and visitors on Wednesday morning, September 23. There will be a garden party at the National Physical Laboratory, by invitation of the director, Sir Joseph Tetavel, on September 24. The British Association Centenary Meeting will include a reception of British Association delegates in the Royal Albert Hall. The Faraday Exhibition will be opened to the public by the president of the British Association, the Right Honorable J. C. Smuts, later in the afternoon. In the evening the presidential address to the British Association will be given by General Smuts, at the Central Hall, in Westminster.

THE JOSEPH HENRY LECTURESHIP OF THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE Philosophical Society of Washington, through its General Committee, has decided to establish a lectureship in honor of its first president, Joseph Henry, Such action at this time is particularly appropriate, since 1931 is the centenary of the discovery of electromagnetic induction, a discovery which has brought honor not only to Henry, but also to Faraday. The purpose and scope of the lectureship can best be shown by quoting the report of the special committee which was adopted by the General Committee:

(1) There is at present in the hands of the treasurer a cash balance . . . and the committee is in agreement that . . . a portion of it be spent . . . in some way which will advance the cause of science and reflect credit on the society.

(2) It is proposed that at suitable intervals of time a speaker be selected to address the society on one of the broad aspects of some field of science, the speaker to review the recent developments or present status of a subject included in or related to the physical sciences.

(3) It is further proposed that the complete address be put in form for publication and submitted to the *Journal* of the Washington Academy of Sciences.

(4) It is further proposed that the aforementioned address shall be called the Joseph Henry Lecture in memory of the first president of the Philosophical Society.

(5) It is further proposed that the first Joseph Henry Lecture be delivered before the society in the fall of 1931, and that thereafter the lecture shall be delivered annually before the society in the spring of the year starting in the spring of 1932.

(6) It is further proposed that the expenses of the speaker incidental to a visit to Washington shall be borne by the society and that in addition an honorarium of one hundred dollars ($100) shall be presented to the lecturer at a suitable time during his visit.

(7) The complete arrangements for any one meeting are to be made by a special committee of three who are to be responsible for selecting the speaker and securing the manuscript in form for publication. No member of the committee should have been a member of the immediately preceding similar committee.

The general committee further provided that the special committee for a given year shall be appointed before October 15 of the preceding year. In accordance with this action, the following committees have been appointed:

For the year 1931: C. G. Abbot, L. H. Adams, *chairman*, R. E. Gibson. For the year 1932: L. J. Briggs, *chairman*, J. H. Taylor, F. E. Wright.

H. L. CURTIS,
President
L. V. JUDSON,
Corresponding Secretary

SCIENTIFIC NOTES AND NEWS

ON the occasion of the centenary meeting of the British Association, which will be held in London in September, the senate of the University of London has decided to confer the degree of doctor of science *honoris causa* on the president, General J. C. Smuts, on Professor Sir F. Gowland Hopkins, president of the Royal Society, and on three former presidents of the Royal Society, Lord Rutherford, Sir Charles Scott Sherrington and Sir Joseph J. Thomson.

THE *Journal* of the American Medical Association states that plans are under way to ask Americans to contribute to a million shilling fund recently started in England as a tribute to Sir Ronald Ross, discoverer of the rôle of the mosquito in the transmission of malaria. Dr. Robert L. Pitfield, Philadelphia, is secretary of the Ross Award Fund of America and will receive checks at his address, 5211 Wayne Avenue, Germantown, Pennsylvania. In addition to Dr. Pitfield, American trustees of the fund are Drs. Thomas McCrae, Joseph McFarland, Francis R. Packard,

Damaso de Rivas, Victor Robinson, Theobald Smith and Frederick L. Hoffman.

THE Roerich Museum has announced the recent election of Professor Chandrasekhara V. Raman, professor of physics at the University of Calcutta, and recipient of a Nobel prize; Professor S. I. Metalnikoff, of the Pasteur Institute, and Dr. E. D. Merrill, director-in-chief of the New York Botanical Gardens, as honorary advisers of the museum.

DR. HOWARD MCCLENAHAN, secretary of the Franklin Institute, has been elected an honorary member of the Royal Institution of Great Britain. The diploma of honorary membership will be formally presented to him at the Faraday Celebration in September. Dr. McClenahan will remain abroad for some time to visit the principal museums of industry and physical science of Europe in order to plan equipment and exhibitions for the new Franklin Memorial and the Franklin Institute Museum.

MR. EDWARD BAUSCH, president of the Bausch and Lomb Optical Company, was awarded the honorary degree of doctor of laws by the University of Rochester at its recent commencement exercises. The award was made in recognition of Mr. Bausch's "noteworthy contribution to optical science in connection with the provision of optical instruments of highest quality for industrial and scientific research."

DR. HOWARD HUNTER CRAVER, director of the chemical division of the Pittsburgh, Pennsylvania, Testing Laboratory, and editor of *The Crucible*, was presented with a gold watch at a dinner preceding a recent meeting of the Pittsburgh section of the American Chemical Society. The watch was given as a token of esteem and appreciation of his services to the Pittsburgh section of the society. Mr. E. E. Marbaker made the presentation speech.

HONORARY doctorates have been conferred by the Institute of Technology at Hannover on Dr. Friedrich Paschen, director of the Physikalisch-Technische Reichsanstalt, Berlin, and on Dr. Hans Stille, professor of geology and paleontology at Göttingen.

THE University of Geneva has awarded its doctorate *honoris causa* to M. Henry Correvon, an expert in Alpine plants and the designer of many Alpine gardens in Switzerland and in England.

AN informal meeting was held at the British Museum on July 11, presided over by the Archbishop of Canterbury, at which a bronze bust was presented to Sir Frederic Kenyon, director of the museum and principal librarian, in recognition of his work for the museum during a period of forty-two years.

FOUR new appointments to the staff of the New York Hospital-Cornell Medical College Association's Center, which will open in September, 1932, are announced by Dr. G. Canby Robinson, its director. The appointments are made a year in advance to enable the men to study the new laboratories and direct their equipment and plan the organization of their departments. The appointments include Dr. Eugene L. Opie, as professor of pathology of the Medical College and pathologist to the hospital; Dr. Herbert S. Gasser, as professor of physiology; Dr. George S. Amsden, as professor of psychiatry and psychiatrist-in-chief of the hospital, and Dr. James M. Neill, as professor of bacteriology and immunology. Professor Opie, now professor at the University of Pennsylvania, succeeds Dr. James Ewing, who will retire as head of the department of pathology after thirty years of teaching in Cornell. He will devote his time to a study of cancer and the problems of the Memorial Hospital, of which he is president of the medical board. Dr. Gasser, now professor of pharmacology in the Medical School of Washington University, St. Louis, succeeds Dr. Graham Lusk, who will retire from the Cornell faculty in 1932 after forty years of teaching. Dr. Neill, who is professor of bacteriology at Vanderbilt University School of Medicine, succeeds Dr. William J. Elser, who will continue as head of the department of applied pathology and bacteriology. Dr. Amsden will open the new department of psychiatry with Dr. William L. Russell.

DR. CHARLES E. SPEARMAN, professor of psychology at University College, London, will retire at the end of the coming academic year, when he will have passed the age of sixty-eight years. Dr. Cyril L. Burt, of the London Day Training College, has been appointed to succeed Dr. Spearman.

DR. FRANCIS BAYARD CARTER has been appointed professor of obstetrics and gynecology at the Duke University School of Medicine. Dr. Edwin C. Hamblen has been appointed associate professor in the department.

DR. HOWARD H. BEARD, assistant professor of biochemistry in the Western Reserve University School of Medicine, has been appointed professor of biochemistry at the Louisiana State University School of Medicine.

DR. JOHN H. PARKER, of the Kansas State Agricultural College, has been appointed acting professor of plant breeding for the year 1931–32 at Cornell University to take the place of Dr. H. H. Love, who is on leave of absence.

DR. GERHARD FUNKHAUSER, formerly of the faculty of the University of Berne and more recently research fellow on the Rockefeller Foundation at the University of Chicago and at Yale University, has been appointed assistant professor in the department of biology of Princeton University.

DR. RAYMOND E. MURPHY has been appointed economic geographer in the school of mineral industries of the Pennsylvania State College.

DR. BURT P. JOHNSON, of the University of Wisconsin, will spend next year investigating virus diseases of plants at the Citrus Experiment Station of the University of California. Dr. Johnson holds a fellowship of the National Research Council and has been research assistant to Dr. B. M. Duggar for the past three years.

MR. ALEXANDER B. KLOTS, of Cornell University, has accepted a position with Ward's Natural Science Establishment as head of the entomological department. He will also be an associate in entomology at the University of Rochester.

DR. WALDO S. GLOCK, of the Ohio State University, has been appointed by the Carnegie Institution of Washington for the year beginning July 1, 1931, as a full-time assistant to Dr. A. E. Douglass, of the Steward Observatory at the University of Arizona, in connection with the work of Dr. Douglass as a research associate of the Carnegie Institution on studies of tree growth and climatic cycles.

DR. T. J. DRAKELEY, since 1919 head of the department of chemistry and of the school of rubber technology at the Northern Polytechnic Institute, London, has been appointed principal of the institute to succeed Dr. R. S. Clay, who will resign on January 1 after serving for twenty-nine years.

DR. A. MURRAY DRENNAN, present professor of pathology in Queen's University, Belfast, has been appointed professor of pathology in the University of Edinburgh.

DR. JOHN F. V. PHILLIPS, who until recently was engaged in ecological research on the tsetse fly problem in Tanganyika Territory, British East Africa, has accepted the position of professor of botany at the University of Witwatersrand, Johannesburg, South Africa.

DR. RICHARD WAGNER, professor of physiology at the University of Graz, has been called to the University of Freiburg im Breisgau.

DR. A. E. LONGLEY, botanist of the U. S. Department of Agriculture, will spend several months at the Scripps Institution of Oceanography making special investigations at the acclimatization station of the department.

MR. FOSTER H. BENJAMIN, who was for some years assistant to Dr. Barnes at Decatur, Illinois, has been transferred to the U. S. Bureau of Entomology and assigned to a position in the National Museum where he will devote most of his time to identification work on North American Lepidoptera. Mr. Benjamin has been for the last three years engaged in work on the Mexican orange worms and the Mediterranean fruit fly for the Plant Quarantine and Control Administration of the U. S. Department of Agriculture.

PROFESSOR ARTHUR H. COMPTON, of the University of Chicago, will during September continue his investigations on the penetrating power and effects of the cosmos rays in the mountains and canyons of Colorado. Dr. Joyce C. Stearns, professor of physics at the University of Denver, is in charge of the expedition, which includes several selected students from both universities. The undertaking is sponsored by the two universities. Members of the expedition will climb Mount Evans, one of the highest Colorado peaks, and will take measurements from this altitude. They will go to Grand Lake to make use of the snow water at a high altitude.

THE British Colonial Office has issued a statement on a Conference of Colonial Directors and Deputy Directors of Agriculture, which was held in London recently to discuss administrative problems in their respective colonies. The conference was opened by the Secretary for the Colonies, and met, normally, under the chairmanship of his agricultural adviser, Mr. F. A. Stockdale. Among those present were the directors of agriculture of Malaya, Kenya and Nigeria, and the principal and commissioner of agriculture of the Imperial College of Tropical Agriculture in Trinidad. The questions discussed related rather to the administration of the agricultural departments than to the technicalities of agricultural research and experimentation. The conference recorded its appreciation of the high standard that has been attained in the training of agricultural officers, and emphasized the necessity for the continuance of the scholarship scheme. Certain suggestions were put forward for the extension of the training now given to the majority of scholars at Cambridge and at the Imperial College of Tropical Agriculture in Trinidad, especially in regard to the economic aspects of agriculture.

DR. UMMA SHUMA SHARGA has recently arrived at Cornell University from the University of Edinburgh to study entomological control methods in this country before returning to India. He will remain in Ithaca about a year.

THE annual meeting of the American Psychological Association will be held from September 10 to 12 at University College, Toronto. Dr. Walter S. Hunter will deliver the presidential address on "The Psychological Study of Behavior" on Friday, September 11.

THE autumn convention of the Electrochemical Society will be held in Salt Lake City, Utah, from September 2 to 5. Dr. Duncan MacRae, of the Edgewood Arsenal, is chairman of the local committee. The headquarters of the meeting will be at Lord Baltimore Hotel. Plans are under way for the sixty-first annual convention of the society to be held in Baltimore from April 21 to 23 in 1932.

THE sixteenth annual meeting of the Optical Society of America will be held at Rochester, New York, from October 22 to 24. In addition to the usual program of papers contributed by members on their own initiative, the meeting will include the following special features: (1) A session devoted to invited papers on "Aerial Photographic Mapping"; (2) a session devoted to invited papers on "Optical Problems in the Motion Picture Industry"; (3) a dinner at the plant of the Bausch and Lomb Optical Company followed by an exhibit illustrating operations of the plant and also some optical phenomena not often seen; (4) the annual society dinner followed by a trip to the University of Rochester to see the new buildings, and (5) the presentation of the Frederic Ives Medal for 1931. Sessions will be held at the Hotel Sagamore, in the auditorium of the new Research Laboratory of the Eastman Kodak Company, and in the Physics Building at the University of Rochester.

THE *Journal* of the American Medical Association announces that the second International Congress of Comparative Pathology will be held in Paris from October 14 to 18, under the chairmanship of Professor Achard, general secretary of the Academy of Medicine. The official topics on the program are: "Vaccination against Tuberculosis," Professor Calmette, Professor Gerlach, of Vienna, Professor Kfouri; "Brucella Infections in Man and Animals," Van der Hoeden, of Utrecht, Martin Kristensen, of Copenhagen, Oluf Bang, of Copenhagen; "Milk as a Pathogenic Agent," Drs. Lesne, Porcher and Tapernoux, of Lyons, Rowel, of Quebec; "Mineral Deficiencies," Simonnet and Randoin, Dr. Sjollema, of Utrecht, H. B. Humphrey, of Washington, D. C., Jacob Eriksson, of Stockholm, Kotte, of Freiburg im Breisgau; "Ultraviruses," Dr. Hauduroy, Professor Flu, of Leyden, Quanjer of Wageningen, Gussow, Canada, and von Brehmer, of Berlin; "Helminthiasis," Professor Joyeux, of Marseilles, and Baer, Stevenel and Lerroux; "Psittacosis," Professor Verge, of Alfort; "Anaphylaxis," Professor L. K. Wolff, of Utrecht; Professor D. Storm van Leuwen, of Leyden, Dr. Koeppenberg, of Groningen.

Industrial and Engineering Chemistry states that the first congress of the new International Association for the Testing of Materials will be held this year, from September 6 to 12, in Zurich, Switzerland, in the buildings of the Swiss Federal Polytechnicum. The association consists of individuals and companies in the various countries. In the United States, the national association through which contacts are established is the American Society for Testing Materials, and many of its members belong to the international body. The objects of the association are to secure international cooperation and the exchange of views and experience on all matters connected with the testing of materials. The chief means of securing this result is the holding of periodical international congresses at intervals of from three to five years. The work does not involve standardization of materials, which is one of the chief functions of the American Society for Testing Materials.

SPECIFIC bequests of more than $175,000 were made in the will of Dr. Richard Alexander Fullerton Penrose, Jr., who left the residue of his estate, valued at $100,000 to Western Reserve University, $50,000 to and the Geological Society of America. The two societies named in the will "are to receive the bulk of the estate in equal parts. The bequests are made in the form of endowment funds and only the income is to be used by the societies." The University of Chicago receives $50,000 to be used for the benefit of *The Journal of Geology,* of which Dr. Penrose was one of the editors for many years. The Economic Geology Publishing Company, incorporated in the District of Columbia, is given $25,000 to be used for the benefit of its journal.

THE will of the late Worcester R. Warner, president of the Warner and Swasey Company, bequeaths $100,000 to Western Reserve University, $50,000 to the Syrian Protestant College at Beirut, and $25,000 each to the American Society of Mechanical Engineers and to the Doshisha College at Kyoto, Japan.

JACOB F. SCHOELLKOPF, of Buffalo, has founded a gold medal to be awarded annually to some chemist in recognition of unusual research in chemistry. It will be presented for the first time at the eighty-second annual convention of the American Chemical Society which meets in Buffalo from August 31 to September 4.

A CORRESPONDENT writes: "The 69-inch reflector for the Perkins Observatory of the Ohio Wesleyan University has reached the final stages of figuring at the optical works of the J. W. Fecker Company, Pittsburgh. The Foucault knife-edge test at the center of curvature exhibits an extraordinarily satisfactory response with temperature changes indicating the excellent quality of the glass which was poured

in the research optical shops of the Bureau of Standards three years ago."

THE *Journal* of the American Medical Association states that a new department of preventive medicine has been established at Tulane University of Louisiana School of Medicine, New Orleans, as the result of an arrangement with the Commonwealth Fund of New York through which the university will participate in the rural health program recently initiated in Mississippi by the fund. An annual appropriation of $25,000 has been allotted by the fund to the school of medicine to establish the new department and to encourage attention to preventive medicine in other clinical departments. Five free scholarships have been established for undergraduate medical students from Mississippi, providing the student with $1,200 a year for four years, with the requirement that after graduation he shall practice at least three years in Mississippi. In addition, fifteen practicing physicians will be sent each year to Tulane for four months' graduate work. Their tuition and transportation to and from New Orleans will be paid by the fund and they will be allowed a monthly stipend of $250. Dr. William Harvey Perkins is head of the new department. The arrangement with Tulane is similar to that made recently with the Harvard University Medical School for practitioners of Massachusetts.

THE Forest Service of the U. S. Department of Agriculture has announced an addition of 16,558 acres of forest land to the national forest area in the Eastern, Southern and Lake states. The National Forest Reservation Commission has approved an expenditure of $52,624 for the purchase of this land. The land acquired will be added to the national forest purchase units which are already protected and administered by the Forest Service for continuous development of forest resources and to safeguard watershed values.

DISCUSSION

THE UNCERTAINTY PRINCIPLE AND FREE WILL

IN his very excellent presentation of the uncertainty principle, published in a recent number of SCIENCE,[1] Professor Darwin concludes with a comment regarding the significance of this principle in connection with the problem of "free will," which should not be allowed to pass without comment. He may be correct in his view that "the question is a philosophic one outside the thought of physics." Yet the reason that he offers to show that the uncertainty principle does not help to free us from the bonds of determinism is inadequate.

Darwin's argument is that "physical theory confidently predicts that the millions of millions of electrons concerned in matter-in-bulk will behave . . . regularly, and that to find a case of noticeable departure from the average we should have to wait for a period of time quite fantastically longer than the estimated age of the universe." He apparently overlooks the fact that there is a type of large-scale event which is erratic because of the very irregularities with which the uncertainty principle is concerned. I refer to those events which depend at some stage upon the outcome of a small-scale event.

As a purely physical example, one might pass a ray of light through a pair of slits which will so diffract it that there is an equal chance for a photon to enter either of two photoelectric cells. By means of suitable amplifiers it may be arranged that if the first photon enters cell A, a stick of dynamite will be exploded (or any other large-scale event performed); if the first photon enters cell B a switch will be opened which will prevent the dynamite from being exploded. What then will be the effect of passing the ray of light through the slits? The chances are even whether or not the explosion will occur. That is, the result is unpredictable from the physical conditions.

Professor Ralph Lillie has pointed out[2] that the nervous system of a living organism likewise acts as an amplifier, such that the actions of the organism depend upon events on so small a scale that they are appreciably subject to Heisenberg uncertainty. This implies that the actions of a living organism can not be predicted definitely on the basis of its physical conditions.

Of course this does not necessarily mean that the living organism is free to determine its own actions. The uncertainty involved may merely correspond to the organism's lack of skill. Yet it does mean that living organisms are not subject to physical determinism of the kind indicated by Darwin.

ARTHUR H. COMPTON

UNIVERSITY OF CHICAGO

GEOMORPHIC NOMENCLATURE

IN any progressive branch of science there arrives a time when the nomenclature adopted in the early stages of that science becomes inadequate, either be-

[1] C. G. Darwin, SCIENCE, 73, 653, June 19, 1931.

[2] Ralph Lillie, SCIENCE, 66, 139, 1927. Lillie draws much the same conclusion as that found here.

cause of inaccurate usage or because of insufficiency in the light of growing conceptions, or for both reasons. This phenomenon is exemplified in the history and present needs of geomorphic nomenclature.

When the conception and the word, peneplain, were simultaneously introduced by the American founder of geomorphic science, Professor William M. Davis,[1] the conception, which this word was manifestly intended to cover, was the land form produced in the penultimate stage of the erosion cycle, the approximate completion of a cycle of erosion over great areas and on large land masses.

Further study of land forms long ago revealed the truth that cycles of erosion are not all of like duration; they may be terminated at any point of progress toward ultimate completion. Where traces of the forms produced in these earlier stages have been preserved, geomorphologists have been content to call them partial peneplains, and more immature forms of still earlier stages have been called terraces or, more recently, straths.

Terrace is too useful a term in its unrestricted meaning to be withdrawn for such a limited and technical use. Strath is defined in the Standard Dictionary as follows: "(Scot.) A wide open valley, usually a river course; distinguished from a glen." This has been its usage by Geikie in "Scenery of Scotland" (p. 156). It is scarcely admissible to use with a new significance a geomorphic term which has a prior and different usage in Great Britain, namely, to designate the broad valley floor unrejuvenated. Several years ago the writer, feeling keenly the need of a term that should not put limitations on so useful a word as terrace (or as bench) and that might be given a restricted technical significance, approached M. R. Campbell and Laurence LaForge of the U. S. Geological Survey for suggestions. The discussion that ensued resulted in the selection of the word *berm*.

Berm is defined in the Standard Dictionary as follows: *"Civ. Eng.* A horizontal ledge part way up a slope; bench. *Fort.* A narrow level space at the outside foot of a parapet, to retain material which might otherwise fall from the slope into the ditch." It is suggested that this term be given a geomorphic usage; it should be used to distinguish those terraces which originate from the interruption of an erosion cycle with rejuvenation of a stream in the mature stage of its development. Dissection, following upon elevation of the land, will leave remnants of the earlier broad valley floor of the rejuvenated stream as a terrace, or berm, and remnants of the uplifted abrasion platform as a seaward-facing terrace, or berm. In different localities every gradation between relatively narrow berms and widely developed peneplains may occur. Considerable latitude should be given therefore in the use of this term, so that it may include berm-like forms as well as typical berms; while those forms more nearly approaching the peneplain might be called partial peneplains.

Such a distinction as the following between berms, partial peneplains and peneplains might be considered: berms, paralleling streams and sea-coast, only cross divides on weak formations; partial peneplains cross divides on rocks of median resistance or on decayed resistant rocks; peneplains are wide-spread on resistant as well as non-resistant rocks.

[1] "The Physical Geography of Southern New England," *Nat. Geog. Monograph*, 1: 276, 1895.

F. BASCOM

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.

LORD KELVIN'S "MORTAL SPRING"

WHEN I began the study of the calculus, using Church's "Elements of the Differential and Integral Calculus," I was greatly bewildered by the reasoning leading to the central principle of the subject, the differential coefficient, latterly the derivative. How a quantity, dx, for example, could be something in the first member of the equation and nothing in the second was a great mystery, and the statement that such was the fact came as something of a shock to one who had begun to associate clarity and rigor with all mathematical processes. It looked, to a novice, suspiciously like smuggling approximation methods into a territory where exactitude alone is permissible.

Since Newton was one of the founders of the calculus I turned to him for light, and examined with care his method of passing, using present-day symbols, from $\frac{\Delta y}{\Delta x}$ to $\frac{dy}{dx}$. After considerable labor I was forced to the conclusion that the passage was made by a flash of intuition, and not by so-called logical rigor. His mind had been prepared, of course, for this great insight by deep and long-continued reflection upon the behavior of variable magnitude. This helped me out, for what was good enough for Newton should, surely, be good enough for me. I proceeded at once to apply the new instrument to the solution of interesting and important geometrical and physical problems, with gratifying results. Confidence in the validity of the processes was quickly and firmly established. My satisfaction with this method was strengthened by the discovery that Comte in his later years veered to the view that there is a transcendental element in the calculus which renders all attempted demonstrations alike irrational and futile. The laws of the calculus, like Newton's laws of motion, are to be accepted because in all their applications they are always found to agree with the facts

of experience. Even quite recently the late Sir Oliver Heaviside, a most original mathematician, committed himself to the opinion that "within the last twenty-five years we have erred in attempting to lead the student to a working knowledge of the calculus by first convincing him that the reasoning is sound. It is quite possible that the fundamental principle of the calculus does not admit of deductive demonstration." I gained an added appreciation of the sage suggestion of the Autocrat at the Breakfast Table that a mathematical demonstration is often a *pons asinorum* over chasms which shrewd folk can bestride without the aid of such a structure. I also found this an advantageous starting point for an examination of the devices for bridging the chasm separating the quotient of increments from the quotient of differentials proposed by D'Alembert, La Grange and Weierstrass and his school.

These early experiences were brought back into the memory with vividness and force when, the other day, I stumbled upon an interesting passage in an article in the *Contemporary Review* for June, 1918. The author of the article is the Rev. Dr. D. S. Cairns, an eminent Scottish divine and professor of dogmatics in the United Free College, Aberdeen. Principal Lindsay, to whom reference is made, was for many years at the head of the United Free College, Glasgow. The quotation follows:

> The great and dramatic moments in the progress of science are when its pioneers, after long brooding over the data which set their problems for them, leap far ahead of all verified knowledge and divine the solution, when Newton goes "voyaging through strange seas of thought, alone," when Darwin sees his unifying truth in a south country lane, and Wallace, ill with fever in the southern island, is "stung by the splendour of a sudden thought." The story of the last century is full of such records, and it is not too much to say that the whole fabric of modern science and industry rests upon the truths discovered in such inspired moments. Let me add another not generally known to these histories. My friend and colleague, the late Principal Lindsay, once told me that Lord Kelvin told him that he never thought his way quite up to any one of his great discoveries. He said that he brooded over the facts, which set him his problem, until there came a moment when his mind made a mortal spring out beyond any thing that he, or any man, could demonstrate, and that he knew then in the very marrow of his mind that the solution lay in a certain fact or set of facts. He said further, and this, I think, is of peculiar interest, that he was never able himself to supply the intervening steps, and that before he announced his discoveries he always got Tait or Clerk Maxwell to work out these intervening steps for him. I repeated this story once to two or three distinguished biologists, one Scottish and the other Continental (both of them, by the way, Gifford Lecturers), and they said at once that that was how the great discoveries of science were always made, that the end was seen before the means.

EVAN THOMAS

UNIVERSITY OF VERMONT

ON "THE NEW CYTOLOGY"

IN the March 20th number of SCIENCE Dr. Alexis Carrel has summarized in a general statement of its problems the principles and methods of the new cytology. In particular he emphasizes the point that "structure and function are two aspects of the same thing" that "must be considered simultaneously." As methods to such an end he describes in some detail his use of tissue culture and also states: "There are two ways of preventing the death of tissues and organs removed from the organism. One was originated by Ludwig and the other by Harrison. Ludwig supplied the blood vessels of an excised organ with artificial circulation of a proper fluid." And after describing the difficulties of this technique, adds, "the old method of the physiologists of the nineteenth century is being rejuvenated, and may become one of the most useful tools of the new cytology."

The purpose of the present communication is to call attention to just such an application we have made of Ludwig's method to cytological problems. Our specific problem was that of experimental nephritis, and in its investigation the method of perfusion was applied to the frog's kidney. In the first article of two which will appear shortly in the *Journal of Experimental Medicine,* we describe the functional disturbances of the kidney lesions following the administration of renal poisons not, as is usually the case, to the living animal, but directly to the isolated organs by way of the modified Locke's solution with which they were perfused. In the second paper the structural changes in the perfused tissues are considered and, to quote from our conclusions, "the two aspects of damage (functional abnormalities and structural change) can be correlated to a reasonable degree."

The structural changes in these perfused kidneys were found to be identical with the anatomical lesions which follow the injection of the same poison into the living frog; in fact, an experimental nephritis was produced in the isolated organs. The finer cytological changes involving the nucleus, such as pyknosis, karyorhexis and karyolysis were observed as well as the protoplasmic changes which accompany cell death. Pathological alterations in the granular and mitochondrial elements of cells were particularly well reproduced in the isolated organ, as for example, "cloudy swelling," mitochondrial clumping and other elements of the classical picture of cell damage. Such changes can not be considered mere artifacts, due to the artificial character of the perfused tissue's environment, for the kidneys functioned in a perfectly

normal manner under the conditions of the experiment before their production and, as will be shown later, the functional response to damage was that which is observed when the kidney is damaged *in vivo*.

In the discussion of our results we have called attention to the significance of the method for problems of normal cytology, as in the histological study of functioning mitochondria or in vital staining. To quote from our conclusions, "The tissues or organs thus studied are isolated from the complications of circulatory and nervous mechanisms, their environment is artificially and rigorously controlled and conditions are therefore analogous in a certain degree to those which obtain in the study of tissue culture." It is obvious, however, that such an application of Ludwig's method may eventually go a step beyond tissue culture, for not only can the reactions of cells and tissues be investigated thereby, but as our experiments with the kidney show, the pathological as well as the normal responses in both structure and function of entire organs can be examined.

The outcome of our experiments suggests that such an extension of Ludwig's method to anatomical investigation as we have employed may complement the method of tissue culture and perhaps aid, as Dr. Carrel hopes, in "a rejuvenation of Virchow's doctrine of cellular pathology."

JEAN OLIVER

LONG ISLAND COLLEGE OF MEDICINE,
BROOKLYN, N. Y.

CHROMOSOMES OF PETUNIA

PRACTICALLY all papers dealing with *Petunia* which have been published during the last four years cite references to show that the typical number of chromosomes for this genus was first recorded in 1927. In the interest of bibliographical accuracy, may I call attention to an abstract[1] published in December, 1924, in which the following statement occurs—"The number of chromosomes is clearly seven and fourteen."

ALICE M. OTTLEY

WELLESLEY COLLEGE

NEWTON'S SAYING

IN the June 12 issue of SCIENCE, Dr. S. A. Mitchell quotes Newton as saying "I have been but as a child playing on the seashore; now finding some pebble rather more polished and now some shell more agreeably variegated than another, while the immense ocean of truth extended itself unexplained before me."

This saying is so important and so often quoted that I think it worth while giving the correct form, which is, "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble, or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

CHARLES HERRMAN

SOCIETIES AND ACADEMIES

THE SECOND INTERNATIONAL CONGRESS OF THE HISTORY OF SCIENCE AND TECHNOLOGY

LONDON, JUNE 29 TO JULY 4, 1931

THIS congress was the outcome of a movement started by the Comité International d'Histoire des Sciences, which was organized at Oslo in 1928 and which meets annually in Paris. This Comité secured the cooperation of its parent body, the Comité International des Sciences Historiques, the History of Science Society, and the Newcomen Society for the Study of the History of Engineering and Technology, and was generously assisted by the British Government, the Science Museum, the British Museum, the Royal Society and the Universities of Cambridge and Oxford. Official representatives were present from the universities of twenty-five countries, and numerous members from these universities and several others. The congress was held under the presidency of Dr. Charles Singer (London), the vice-presidents being Professor Gino Loria (Genoa) and Dr. George Sarton (Harvard). The following is the program of sessions and a summary of the papers.

INAUGURAL SESSION, MONDAY, JUNE 29

The congress was opened by an address by the Right Honorable H. B. Lees-Smith, M.P., president of the board of education, who expressed his belief that the greatest events in the history of the world had taken place in the realm of ideas, and particularly in the ideas developed in the minds of men of science and technology. The achievements of science and technology, he said, were now progressing with such rapidity that the mind has become dazed and has almost lost the capacity for surprise. He asserted that science and technology were immeasurably beneficent and at the same time completely merciless, furnishing the world with fearful instruments of destruction in war and with the means for saving the lives

[1] Margaret C. Ferguson, "Preliminary Announcement of a Cytological and a Genetical Study of Petunia," *Anat. Abst.*, 28–29, No. 116, p. 137, 1924–1925.

of the wounded. He raised the question whether the moral progress of mankind was keeping pace with the material development. If not, another great war like the last would see the end of western civilization.

In his presidential address Dr. Singer urged that the teaching of the history of science should replace the present history of conquest, asserting that the rise of science was the most important event in human history since the fall of the Roman Empire, and that text-books which did not say as much did not teach the truth. The critical years which saw the foundation of the Royal Society, the publication of Hooke's "Micrographia," Newton's work on prisms and his "Principia" were, he asserted, generally referred to in school histories only in connection with battles.

At the close of the Monday session the members were received for tea at the Science Museum by the president of the Board of Education and Mrs. Lees-Smith, and by Sir Henry Lyons (director of the Science Museum) and Lady Lyons. In the evening Dr. and Mrs. Singer gave a reception at the Royal Society of Medicine. This was followed by an interesting and informative address by Professor E. N. da C. Andrade, who impersonated in manner and dress Francis Hauksbee, F.R.S., who died in 1713 and was one of the pioneers in the study of electricity. The address was based upon one originally delivered by Hauksbee under the title, "A Discourse with Experiments on Various Subjects, Giving an Account of Several Surprising Phenomena, Touching Light and Electricity, with many other Remarkable Appearances Not Before Observed," and was illustrated by experiments made by him, in which use was made of the original air-pump which he constructed. In the course of the address Hauksbee's prognostication of the incandescent electric light appeared. Later in the evening there was an exhibit of material from Dr. R. C. Clay's collection of historical optical instruments and from Mr. G. H. Gabb's collection of Priestley relics.

On Tuesday two sessions were held at the Science Museum. The first was devoted to the topic, "The Sciences as an Integral Part of General Historical Study," with Professor Gino Loria (Genoa) as chairman, the opening address being delivered by Professor G. N. Clark (Oxford). The former gave a general summary of the situation, after which the latter, speaking as one concerned mainly with international relations, showed the necessity for studying the history of technology if the problems of war, industry and transportation were to be understood, and asserted that the fundamental principles of politics, philosophy and social organization could not be studied in isolation from those of science. Addresses in the form of discussion of the major topic were then delivered. Sir William C. D. Dampier-Whetham (Cambridge) divided history into four periods, (1) the picturesque (kings, battles), (2) legal and constitutional, (3) economic (the industrial revolution), and (4) that in which science stands supreme. Professor A. V. Hill (London) compared for importance certain military achievements with contemporary scientific discoveries, such as the year of the middle of the Thirty Years War (1628) with the publication of the small Latin treatise of seventy-two pages, by Harvey, on the circulation of the blood; and he asserted that the achievements of Darwin, Newton, Faraday, Maxwell and Rutherford had a more worthy claim in text-books for children than the events now chronicled. Professor A. M. Mosharrafa (Cairo) spoke of the four characteristic aspects of contemporary thought with respect to physical science—(1) the revolutionary aspect, (2) the tentative aspect, (3) the philosophic aspect, (4) the mystical aspect—and asserted that the method of science, in contrast with its outlook, has remained substantially unaltered. Dr. E. J. Holmyard (Clifton College, Bristol) called attention to the fact that the twelve large volumes of the "Cambridge Modern History" contain only fifty pages on the history of science.

The second session was devoted to the topic, "The Teaching of the History of Science," Dr. W. H. Welch (Johns Hopkins) acting as chairman. The opening address (in French) was delivered by Professor Aldo Mieli, permanent secretary of the Comité International d'Histoire des Sciences (Paris), who called attention to the fact that the educative value of the history of science in general culture has been recognized only recently, that the science of to-day is only an instantaneous photograph of a present in perpetual development, and that the history of the subject is bound to have a place in the regular courses in our schools. The discussion was opened by Professor A. E. Heath (University College, Swansea), who took for his thesis the statement that historical considerations gain in importance as science makes life more complex, and hence that the more the physical sciences gain in importance, the greater the need to see them in wider perspective. Professor A. Wolf (London) sketched the story of the introduction of the history of science into the curriculum in London and stated some of the problems involved. Professor David Eugene Smith (Columbia) spoke of the value of the history of mathematics in eliminating the obsolete and in selecting appropriate substitutes. He described the three-year course given by him prior to his retirement from active service. Professor Q. Vetter (Prague) described (in French) the teaching of science in Czecho-Slovakia, speaking of the steps taken in the reform of the schools under the new régime. Dr. F. H. Hayward (inspector, London)

proposed the introduction of "Celebrations of Science" in the schools, the purpose being to keep specialists in science in contact with the vast and growing knowledge of other branches, and the general public in contact with the growth of science. Professor M. Stephanides (Athens) spoke (in French) on the history of the sciences in Greece, calling attention to the danger of its becoming merely archeologic in its nature. He described the general plan of his course. Mr. F. S. Marvin (Cairo) described three channels by which the history of science may profitably be taught—(1) by incorporating it in courses in general history; (2) by class and laboratory work in historic experiment and discovery, and (3) by special courses in the history of the sciences already studied—and spoke of the advantages and disadvantages of each. Mr. Thomas Greenwood (London, Birkbeck College) presented the claims of mathematics as a necessary constituent element of both philosophy and technology, stressing the demands of philosophy. M. Emile Meyerson spoke (in French) upon the efforts made in the past to consider the relation of science to history and urged the necessity of training teachers to meet the present needs.

Some interest was aroused in the Tuesday meeting by the request of the Soviet delegation that five of its members might be heard. Each delivered a prepared address and this, with various others of members of the delegation, was circulated in printed form to all present at the congress. The general nature of these addresses (eleven in number) may be inferred from the following quotations from one of those most forcefully presented, that of Professor M. Rubinstein (Moscow Institute of Economics):

> The relations between science, technology and economics under the conditions of capitalistic society and under the socialistic system that is being built up in the Soviet Union, are distinctly different and in many respects, diametrically opposite. The capitalistic system of production and social relations is antagonistic by its very nature. Along with its growth and development there goes on the development and growth of the profoundest intrinsic contradictions that are manifest in all branches of human existence without exception. . . . The social system for one sixth of the world has now become Socialism. And one can not understand anything about the future perspectives of science and technology as well as about the perspectives of their interdependence, without the study of the laws of development, of the struggle and growth of the new socialistic system of social relations.

That each of these papers was manifestly a contribution to Soviet propaganda of socialism, rather than to the history of science and technology, does not detract from their interest.

On Wednesday and Saturday there were no sessions of the congress, a large number of the members visiting Cambridge and Oxford, respectively, being entertained at luncheon and tea at various colleges. There was also an Independence Day Luncheon at University College, London, on July 4.

On Thursday the session was devoted to the "History and Contemporary Interrelationship of the Physical and Biological Sciences," under the chairmanship of Professor William Ritter (California). The opening addresses were delivered by Professor J. S. Haldane (Oxford), Dr. E. S. Russell (Board of Agriculture) and Dr. Joseph Needham (Cambridge). Professor Haldane expressed the view that in the study of each example of life we are confronted by experiences which can only be interpreted as the manifestation of a persistent and indivisible unity, recognized quite naturally and in common language as the life of the organism and the stock to which it belongs, and showing itself in endless coordinated details of form, environment and activity which express it. In physical science we are dealing with what we interpret as separable material parts and events; but in biological science we are dealing with what we can never interpret in this way, since the parts and events are manifestations of the coordinated whole which we call the life of the organism. When Galileo took the first definite steps towards a physical interpretation of our experience he entered upon what proved an extraordinarily fruitful path, but he made a mistake by assuming that his interpretation was "objective" or represented fundamental reality. It has been accepted generally by the scientific world up to the present time, but has made any satisfactory scientific treatment of biology impossible. Dr. Russell was also of the opinion that the influence of the physical sciences on biology has been, on the whole, unsatisfactory. The doctrine of Descartes, that animals may, and for the purpose of science should, be treated as automata, has prevented the development of a real science of animal behavior and hence of animal ecology. Dr. Needham joined in objecting to an interpretation of biology from the purely physical standpoint. Any such demand implies the physics of the future and not only the physics of to-day. The speaker adduced various illustrations to establish his thesis. All through the history of biology we see the pendulum swinging backwards and forwards between more or less crude mechanism and belief in physics, on the one hand, and more or less crude vitalism and the skepticism of physics, on the other. Dr. J. H. Woodger (London) stated that the attempts to understand relationships between physical and biological sciences have been vitiated by the long-drawn-out scandal of the metaphysical quarrels between mechan-

ists and vitalists. He called attention to the method of procedure necessary to lead to safe conclusions, paying a tribute to the work of such scholars as Whitehead and Russell. Professor Lancelot Hogben (London) called attention to the fact that there was never a time when biologists were more confident of the usefulness of physico-chemical methods in arriving at conclusions as to the behavior of organisms, or when there was such wide-spread alarm at the philosophical consequences of admitting that this is the case. This contradiction is due in part to the ecclesiastical origins of Western culture and partly to contemporary social unrest. In our generation materialism has become the official creed of 150,000,000 people, but among men of science the mechanistic tradition is not at present fashionable in spite of its growing strength in laboratory practice. Mr. L. L. Whyte called attention to the new type of fundamental law established by recent atomic theory, particularly with respect to the quantum theory, which became estabilized in 1927 and has not seriously been modified in the last four years.

Professor L. G. M. Baas-Becking (Leiden) asserted that infinity and limitation in space and time, continuity and discontinuity, free will and predestination and the existence of God were kindred and basic antimonies which could perhaps be derived from one another, and that a synthetic solution for one might solve the whole.

The session on Friday was devoted to the topic "The Interdependence of Pure and Applied Science," the chairman being Sir Henry Lyons, director of the Science Museum. There were two opening addresses, the first by Sir W. Napier Shaw and the second by Professor William McDougall. The former considered the expansion of the Socratic distinction between pure and applied science to express the development of science in terms of (1) an observatory for the acquisition of experience, (2) a laboratory for the formation of ideals, (3) a library for the development of cooperation, and (4) an arena for exposition and discussion.

In the discussion, Professor Dannemann (Bonn) stated that a great part of the deliberations were concerned with the question of how natural or technical subjects may be connected with their history. He was convinced that the general synthesis or comprehension of the sciences and their connection with the history of civilization must be the work of one man, and such a work he has already planned. Professor C. H. Desch (Sheffield) deplored the fact that popular interest lay rather in the applications of science than in science itself. The continuity of scientific discovery is the important thing, for inventions are the result of long preparation in pure science. Professor F. G. Donnan (University of London) was of the same opinion and urged the encouragement of theoretical study in the field of industry. Mr. R. V. Vernon (Colonial Office) joined the preceding speakers in the hope that pure science might be encouraged without direct interest in its applications. In particular he expressed appreciation for the attitude shown in government service. Dr. G. Windred called attention to the many examples of the manner in which pure science has produced discoveries of great practical value in the field of electrical theory. Among others was the case of Oersted's observance (1820) of the magnetic effect of an electric current, followed by the work of Biot, Savart, Ampère and Maxwell. Mention was also made of the theoretical work of Kelvin, Maxwell, Chasles, Faraday, Stokes, Wilhelm Weber, Sir J. J. Thomson, Kennelly, Heaviside, H. von Helmholtz, and others. Dr. Marie C. Stopes (London) spoke upon the relation of pure science to the study of the coal situation. Dr. A. Joffe (Leningrad), one of the Soviet delegates whose papers were issued in pamphlet form, confined himself more closely to the scientific question than some of his colleagues had done and specified clearly eight problems "forgotten by physicists yet of importance to technique." Of these the first was "A reversible oxidization of coal" which, he stated, "could three or four times increase the energy available for technical purposes."

Abstracts of papers were also circulated, including one by Messrs. H. E. Stapleton and Hidayat Husain, "Report on the Mā al-Waraqi," an unpublished work of the tenth century on alchemy and its relation to later European treatises. Dr. S. V. Larkey (California) reported on his studies in the field of early English medicine and biology. A statement as to the project for the publication of Newton's correspondence was also circulated, suggesting that 1942, the tercentenary of the birth of Newton, would be an appropriate time for the work to appear. Circulars relating to the proposed scientific section of the Chicago Centennial Exhibition of 1933 were also distributed.

Mention should also be made of the exhibit in the British Museum relating to the First Century of Science in England (Bruno to Newton, 1584–1687). Printed works of twenty-eight scientists were shown. A special catalogue of the portraits of scientists in the National Portrait Gallery was also issued.

Numerous visits to places of interest in London were planned and several receptions were given, notably those at the Royal Society by the president, Sir Frederick Hopkins, and Lady Hopkins; at the Royal Institution by the president and managers; at the Institute of Historical Research, by the director

and committee; at the Royal College of Physicians, by Lord Dawson, of Penn, and Lady Dawson, and the one by Dr. and Mrs. Singer, as already mentioned. On Friday evening a banquet was held at which various delegates spoke.

DAVID EUGENE SMITH

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A TRIPLE-SPECTRUM DISCHARGE TUBE

THE mercury-vapor lamp is probably the most generally useful light source for spectroscopic, optic and general instruction laboratories. Many times, however, the supply of lamps is not equal to the demand, and the availability of inexpensive substitutes is very desirable. For this reason the possibilities of the electrodeless discharge were investigated, and it was thought that the results obtained might be of general interest.

A pyrex glass tube A about 20 cm long and 4 cm in diameter was provided with a side tube B and a "sucked-in" thin glass end C.[1] Ten grams each of zinc, cadmium and mercury were placed in the tube. The tube was placed in an oven and baked at 450° C. for several hours, while the gases in the tube were removed by a mercury diffusion pump. During the baking-out process the mercury was kept in B, which was arranged to be out of the oven. Just before the tube was sealed off at D, the mercury was distilled from B to A.

The completed tube was mounted in an asbestos box equipped with two "Glo-coils" as shown in the figure.

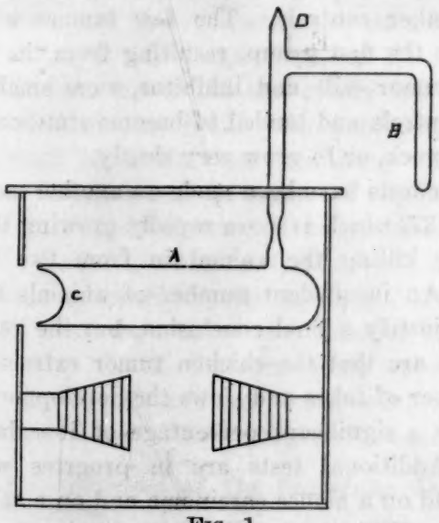

FIG. 1

A helix of 8 turns of No. 8 copper wire was placed around A. The helix was connected in series with a variable spark gap and the secondary of a 1 K.V.A. Thordarson transformer. Three Leyden jars were connected in parallel with the helix. The variable spark gap, which was enclosed in a sound-proof box, is essential to obtain a discharge which fills the entire tube. In order to prevent the mercury from depositing on C while the tube is in operation, the helix should extend well to the end of the tube. Best results are obtained if large-sized wire is used for all electrical connections.

Three quite distinct types of discharge may be obtained with this tube.

(1) If all the mercury is left in A and the tube slightly warmed, a discharge quite comparable in intensity to ordinary mercury arcs results. Mercury and zinc lines are prominent. In the present case the thin glass window transmitted with great intensity ultra-violet radiation to 2,536 Ang.

(2) By heating the tube strongly a large part of the mercury may be distilled to B and the discharge becomes bright green. In this case the visible spectrum consists largely of the strong mercury lines and the cadmium triplets.

(3) If practically all the mercury is distilled to B, the tube may be operated to give a very steady discharge even when cold. In this case mercury, zinc and cadmium lines are present. The cadmium red line—the international standard—appears quite strongly under these conditions.

The result is an inexpensive but brilliant light source which transmits the ultra-violet well and which produces lines extending well into the red—facts which make the tube desirable for spectroscopic calibration. The lines are very sharp, since the tube may be operated at low temperatures and the Doppler effect is small.

R. WILLIAM SHAW
GEORGE B. SABINE
CORNELL UNIVERSITY

[1] C. M. Slack, *J. O. S. A.*, 18, 123, 1929.

THE ADJUSTABLE DOUBLE SLIT

MR. R. WILLIAM SHAW recently (SCIENCE, Vol. 73, April 24, 1931) described an ingenious mechanism permitting the continuous variation of the distance between two optical slits. A more complicated apparatus with means for adjusting also the widths of the two slits was devised by L. E. Dodd and G. H. Jung. (J. O. S. A. and R. S. I., Vol. 15, p. 181, 1927.) Adjustable double slits have been used chiefly for laboratory repetition of Michelson's stellar interferometer experiment.

The special problem of the adjustable double slit is, as Shaw points out, that of keeping the varying space between the slits closed. Shaw accomplishes this by sliding between the slits a tapering brass plate; Dodd and Jung employ a rolling curtain, similar to a window shade.

A method used here with success may be worthy of record on account of its simplicity. Two thin, rectangular plates, which may be of either cardboard

or brass, are hinged together along one edge and the hinge made light-tight by a backing of black paper. The free edges opposite the hinge are attached respectively to the inside jaws of the two slits. As the slits are caused to recede from or to approach each other these plates open and close like a book. When used as in the stellar interferometer the back of the book is directed away from the telescope objective and is out of the way of all other parts.

PAUL KIRKPATRICK

DEPARTMENT OF PHYSICS,
UNIVERSITY OF HAWAII

SPECIAL ARTICLES

FURTHER OBSERVATIONS ON AN INHIBITOR PRINCIPLE ASSOCIATED WITH THE CAUSATIVE AGENT OF A CHICKEN TUMOR[1]

IN recent communications[2] attention has been called to certain evidence indicating the presence of an extractable principle in a chicken tumor, which tends to inhibit the activity of the causative agent in the transmission of this tumor. The present report deals with some additional properties of this inhibiting agent.

The most satisfactory source of this material has been found to be the desiccate of a relatively slow-growing Chicken Tumor I. A solution is prepared by extracting the desiccate with water, filtering through paper and then heating at 55° for 30 minutes to destroy the tumor-producing factor in the extract. This material, mixed with equal volumes of various concentrated, highly active fresh tumor extracts, shows a marked inhibiting action. The results of 69 test inoculations showed complete neutralization of the activity, with no tumor formation, in 59 cases (86 per cent.). The remaining 10 cases gave evidence of considerable inhibiting activity, in that the resultant tumors were, without exception, much smaller than the controls. The 30 control inoculations of the fresh extract in every instance resulted in actively growing tumors. It was further observed that heating of the extract to 65° or over damaged or destroyed the inhibiting action.

An extract of Chicken Tumor 10, a slow-growing fibrosarcoma, heated to 52° C, has been found to inhibit the development of Chicken Tumor I, a rapidly growing tumor. The results of 31 tests gave complete neutralization in 8 cases (26 per cent.), and the average size of the tumors in the remaining animals was definitely smaller than in the controls. The latter group showed 100 per cent. of actively growing tumors.

The outcome of the above experiments suggested that the inhibitors might not be so specific in their activity as the etiological agents. On the basis of this possibility, tests have been made on the action of the inhibitor on transplantable mouse sarcomas. One of the standard tumors, designated as 180, a sarcoma which gives a high percentage of takes and rarely if ever retrogresses when once established, was selected for the first test. Of 94 inoculations of tumor cell suspension, mixed with equal volumes of chicken tumor extract previously heated to 55° C, no tumors developed in 83 cases (88 per cent.). In the control group of 70 inoculations of the same tumor cell suspensions diluted with Ringer's solution, there were 15 cases (21 per cent.) which developed no tumors. Further controls with extracts of chicken liver and brain, with normal rabbit and chicken serum, and with the chicken tumor extract heated to over 65° C gave no significant variation in the number of takes or in the growth rate of the tumor from those shown by the other controls. The few tumors which occurred in the first group, resulting from the inoculation of tumor cells and inhibitor, were smaller than in the controls and tended to become stationary after the first week, or to grow very slowly.

Similar tests have been made on another mouse sarcoma, S/37, which is more rapidly growing than 180, generally killing the animal in from two to three weeks. An insufficient number of animals has been used to justify a final conclusion, but the general indications are that the chicken tumor extract reduces the number of takes and slows the development of the tumor in a significant percentage of inoculated animals. Additional tests are in progress with this tumor and on a mouse carcinoma and on a rabbit epithelioma. With the latter two neoplasms the preliminary experiments show little indication of any retarding action by the "inhibitor."

It is considered that the action of the inhibitor on the chicken tumor agent is probably a neutralizing phenomenon. With the mouse tumor the possibility exists that the result may be due to an incidental enzyme in the chicken tumor extract, which damages the tumor cells. The fact that the treated mouse tumor cells appear to multiply for a few days after

[1] From the Laboratories of the Rockefeller Institute for Medical Research.

[2] Jas. B. Murphy, O. Helmer, A. Claude and E. Sturm, SCIENCE, 73, 266, 1931; Jas. B. Murphy, *Trans. Assoc. Amer. Physicians*, May, 1931 (in press); M. J. Sittenfield, A. S. Johnson and J. W. Jobling, *Proc. Soc. Exp. Biol. and Med.*, 28, 517, 1931.

inoculation and the absence of any signs of damage to the host tissues at the site of inoculation are, however, some indications that this is not the correct explanation.

JAMES B. MURPHY
ERNEST STURM

HUMAN SERUM, AGE AND MULTIPLICATION OF HOMOLOGOUS FIBROBLASTS[1]

THE experiments of du Noüy[2] have shown that the rate of cicatrization of a sterile wound is a function not only of the area of the wound but also of the age of the patient. Simply stated, the area of the wounds being the same, the rate of repair is faster in young individuals than in old. Later work by Carrel and Ebeling,[3] and by Baker and Carrel,[4] has demonstrated that these findings may be explained on the basis of progressive physico-chemical changes which take place in the blood plasma during the lifetime of the individual. These authors have shown that the inhibiting action of homogenic and heterogenic serum on the growth of pure cultures of chicken fibroblasts is directly proportional to the age of the animal from which the serum is taken. This process of aging, which advances more rapidly during early life, is due, in part at any rate, not only to the loss of growth-activating substances, but also to an increase in concentration of inhibiting proteins and lipoids, particularly the latter. The curve representing the increase of these substances resembles the curve of the index of cicatrization, of du Noüy's formula, as a function of the age of the individual. After extraction of the lipoids, the remaining proteins are found to be far less inhibiting than the whole serum. Also, when the serum of an old fowl is diluted so that its protein concentration corresponds practically to that of a young fowl, its growth-inhibiting power, although markedly decreased, is still higher than that of the serum from the younger animal. Carrel[5] has also shown that the toxic substances which characterize old age are being continuously secreted by the tissues. Their progressive accumulation in the blood is not the result of lack of elimination from the circulation; it is rather an expression of the condition of the tissues. When the blood plasma was removed from old dogs by plasmaphaeresis, and was replaced by Tyrode solution, their serum was less inhibiting for a short time thereafter, but rapidly regained its former characteristics as the plasma was regenerated by the tissues. This recovery took place too rapidly to allow of a definite modification of the tissue cells.

The experiments here to be reported bring additional evidence of a confirmatory nature by demonstrating a striking contrast between the action of infant and adult sera on colonies of human fibroblasts cultivated *in vitro*. The fibroblasts were derived from a subcutaneous rheumatic nodule removed at biopsy from a seven year old male, and have been cultivated for three months in flasks on a medium consisting of a mixture of 20 per cent. adult human serum and 80 per cent. chick embryo tissue juice. When the experiments were made, this strain had been cultivated for almost two months and had been subdivided and transferred seven times. The cultures selected for the experiments were divided and the two halves of each were placed in separate flasks. One half of each was treated regularly with serum obtained from a 14 months old infant and the other half with serum from a 27 year old adult. In order to intensify the effect of the sera to be compared, the usual proportions were reversed so that the mixture consisted of 80 per cent. serum and 20 per cent. chick embryo juice. The results obtained from three such experiments which were made simultaneously, and with the same materials, have been averaged and presented in Fig. 1. It may readily be seen that the cultures

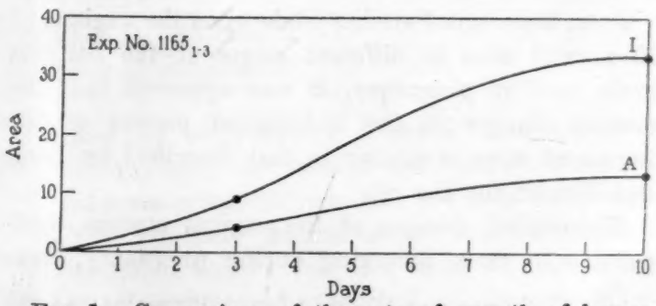

FIG. 1. Comparison of the rate of growth of human fibroblasts in the sera of a 14 months old infant and a 27 year old adult. I = infant's serum; A = adult serum.

treated with the infant's serum attained an area in ten days which was over 150 per cent. greater than that reached by those treated with adult serum.

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[1] From the Laboratories of The Rockefeller Institute for Medical Research.

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Research, for material used in connection with the experimental work.

RAYMOND C. PARKER

THE ROCKEFELLER INSTITUTE,
NEW YORK, N. Y.

A PRACTICAL TEST FOR POTENCY OF EXTRACT OF CORPORA LUTEA

THE large amount of work which has been done, in the last few years, upon extracts of corpora lutea, and the results of that work, have urgently called for a suitable test for potency. Corner's and Allen's[1] studies on progestational proliferation in the rabbit, resulting from the physiological action of their extract of the corpus luteum, and Hisaw's and Leonard's[2] similar results, provided a useful test, but one which had several practical objections, arising primarily from the relatively large size of the test animal, and the consequent expense of obtaining and maintaining the animals and of making the tests.

To overcome these objections, W. M. Allen[3] attempted to transfer the application of this technique, using rats as test animals. As a result of thorough studies, he concluded that "The histological alterations of the rat's endometrium during pseudopregnancy are insufficient to warrant the use of these changes as a test for corpus-luteum extracts." At the same time we obtained wholly confirmatory, though as yet unpublished, results in this laboratory. We also had similar results in studies conducted on the uterus of mice.

The results of our studies upon histological changes in the vaginal mucosa of mice have, however, been very satisfactory, and we now present some of them as the basis of a practical test for potency of extracts of corpora lutea.

From histological studies made upon the vaginae of 19 normal mice in different stages of the oestrous cycle, and of pregnancy, it was apparent that the normal changes in the histological picture of the vagina of mice is similar to that described by Long and Evans[4] for the rat.

Histological changes of the vaginal mucosa, comparable to those occurring during pregnancy, were found when normal, adult, unmated, female mice were treated, just after oestrus, with an extract of corpora lutea, in all of 13 test animals, treated with daily injections of extracts for periods ranging from 3 to 14 days. For test purposes, however, it is recommended that periods of more than 7 days be used.

At present we recommend the following test: Beginning the day after oestrus, make daily injections of 0.25 cc. of corpus-luteum extract per test animal for a period of 9 to 14 days. The vagina, upon being preserved, sectioned and stained, according to the usual histological technique employed in such cases, will show, with an extract potent for maintaining pregnancy in ovariectomized, pregnant animals, a histological picture characteristic of pregnancy, *i.e.*, absence of cornified epithelium and of infiltration of leucocytes, presence of vacuolization of the superficial and middle cell layers, mucous transformation, *et cetera*.

This test has several obvious advantages. The test animals are small, easy and inexpensive to obtain and maintain, and the test occupies a relatively short period. Furthermore, 2 to 3 ccs. of extract is sufficient to make a test upon one animal. It may even be that a smaller dosage than that of 0.25 cc. per day will be found to be effective, as the minimal effective dose has not yet been ascertained. Experienced workers will also probably find that the period of time recommended for the test may be reduced with safety.

The extract used in these tests was one prepared by Dr. J. J. Pfiffner, and has been the basis of much of our work upon the physiology of corpus-luteum extract. It is similar to Corner and Allen's extract, save that methyl alcohol is used in place of ethyl alcohol as the first extracting agent.

Similar tests made as controls upon five animals with Swingle and Pfiffner's[5] extract of the adrenal cortex did not bring about a pregnant appearance of the vaginal mucosa in non-pregnant mice.

REGINALD G. HARRIS
DOROTHY M. NEWMAN

THE BIOLOGICAL LABORATORY,
COLD SPRING HARBOR, L. I., N. Y.

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